

## **MEMORANDUM**

**TO:** Paul Foster, P.E.

**FROM:** Ravi Rangan, P.E.

**SUBJECT:** Application for the Construction of Selective Catalytic Reduction (SCR) Systems for the Combined Cycle Units I & II (*aka* DCRC CCU SCR Project) at the Delaware City Power Plant (DCPP) in Delaware City Refining Company's Delaware City Refinery.  
**Permit:** **APC-97/0503-CONSTRUCTION (NSPS)(Amendment 10)**

**DATE:** May 14, 2014

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### **Background:**

The Delaware City Refining Company (DCRC) owns and operates a petroleum refinery and power plant (DCPP) in Delaware City, Delaware. The DCPP supplies most of the steam and electricity required for operation of the combustion turbines with heat recovery steam generators). The combined cycle units (CCUs) operate under permit AQM-003/00016-Part 3 and APC-95/0503-Operation (Amendment 8)(NSPS). Each CCU consists of a general Electric Model PG6101FA gas turbine fired by natural gas and rated at 780 mmBtu/hour (HHV) and a downstream duct burner fired by either natural gas or refinery fuel gas and rated at 192 mmBtu/hour. DCRC's present permit application seeks permission to install selective catalytic reduction (SCR) systems on each CCU to control NO<sub>x</sub> emissions.

### **Purpose of Project:**

On May 31, 2010, the Delaware Department of Natural Resources and Environmental Control (DNREC) and DCRC entered into an agreement (the DCRC Agreement) to address and clarify certain environmental regulatory considerations relevant to DCRC's acquisition and operation of the DCR.<sup>1</sup> Section I of this agreement provides for the establishment of a facility-wide NO<sub>x</sub> emission limitation for all permitted sources at the DCR. This NO<sub>x</sub> emission cap has been developed and incorporated into DCRC's TV permit which was issued on April 5, 2011 and is structured as follows:

- The initial NO<sub>x</sub> Cap for the Refinery shall be 2525 tons per year, evaluated over each twelve (12) consecutive month rolling period, commencing with the rolling twelve (12) consecutive month period comprised by calendar year (CY) 2011 and ending with the twelve (12) consecutive month rolling period that ends on December 31, 2013.
- The NO<sub>x</sub> Cap will be further reduced to 2225 tons per year, evaluated over each twelve (12) consecutive month rolling period comprising calendar year 2014.
- The NO<sub>x</sub> Cap will be further reduced to 1650 tons per year, evaluated over each twelve (12) consecutive month rolling period, commencing with the twelve (12) month rolling period beginning on January 1, 2015 and ending on December 31, 2015, and continuing thereafter.

As part of the process outlined in the DCRC Agreement, DCRC was required to submit a non-binding plan describing the method by which it would obtain the necessary NO<sub>x</sub> reductions to satisfy the established NO<sub>x</sub> caps. On December 28, 2010, DCRC provided DNREC with DCRC's preliminary, non-binding plans to

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<sup>1</sup> Agreement governing the Acquisition and Operation of Delaware City Refinery dated May 31, 2010 herein after referred to as the DCRC Agreement.

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reduce overall NO<sub>x</sub> emissions from the Refinery to 2,225 tons per year on a rolling 12-month basis, for the twelve month period comprising calendar year 2014. One of the methods thus identified by DCRC was to implement fuel switching at the CCUs to allow combustion of natural gas and refinery fuel gas as fuels in the combustion turbines and duct burners, and surrendering the authorization to use syngas and ULSD as fuels<sup>2</sup>. As a subsequent NO<sub>x</sub> control measure, DCRC identified the installation of SCRs on the 2 CCUs to yield additional NO<sub>x</sub> reductions in order to meet the declining NO<sub>x</sub> Cap of 1,650 TPY which will become effective at the end of 2015.

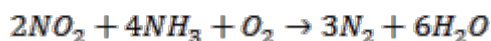
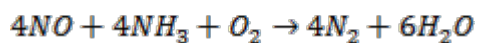
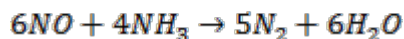
DCRC states that it has evaluated the emissions changes associated with this project and determined that Prevention of Significant Deterioration (PSD) and nonattainment New Source Review (NANSR) regulations do not apply to this project. The application states the CCU SCR Project will not result in a significant net emissions increase for any regulated pollutants. Instead, this project will result in a significant reduction of NO<sub>x</sub> emissions, and is being implemented in support of the Refinery's overall efforts to reduce NO<sub>x</sub> emissions from the facility as further described below.

### **Project Description:**

This project has the following aspects:

- Installation of modularized catalyst beds in the existing HRSG exhaust duct;
- Installation of reagent distribution headers; and
- Addition of an ammonia vaporizer along with aqueous ammonia metering facilities and automatic controls.

SCR works by injecting a controlled quantity of ammonia into the exhaust gas stream from the CCUs. This stream is then passed over a metal oxide zeolite catalyst. The zeolite catalyzes the reduction of NO<sub>x</sub> to nitrogen and water as shown by the following reactions:



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<sup>2</sup> Syngas and ULSD were used by Valero (the former owners of the DCR) as fuels for the CCUs until 2009. When PBF Energy acquired the DCR, the gasifiers were permanently shut down.

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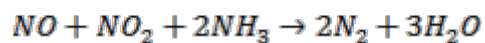
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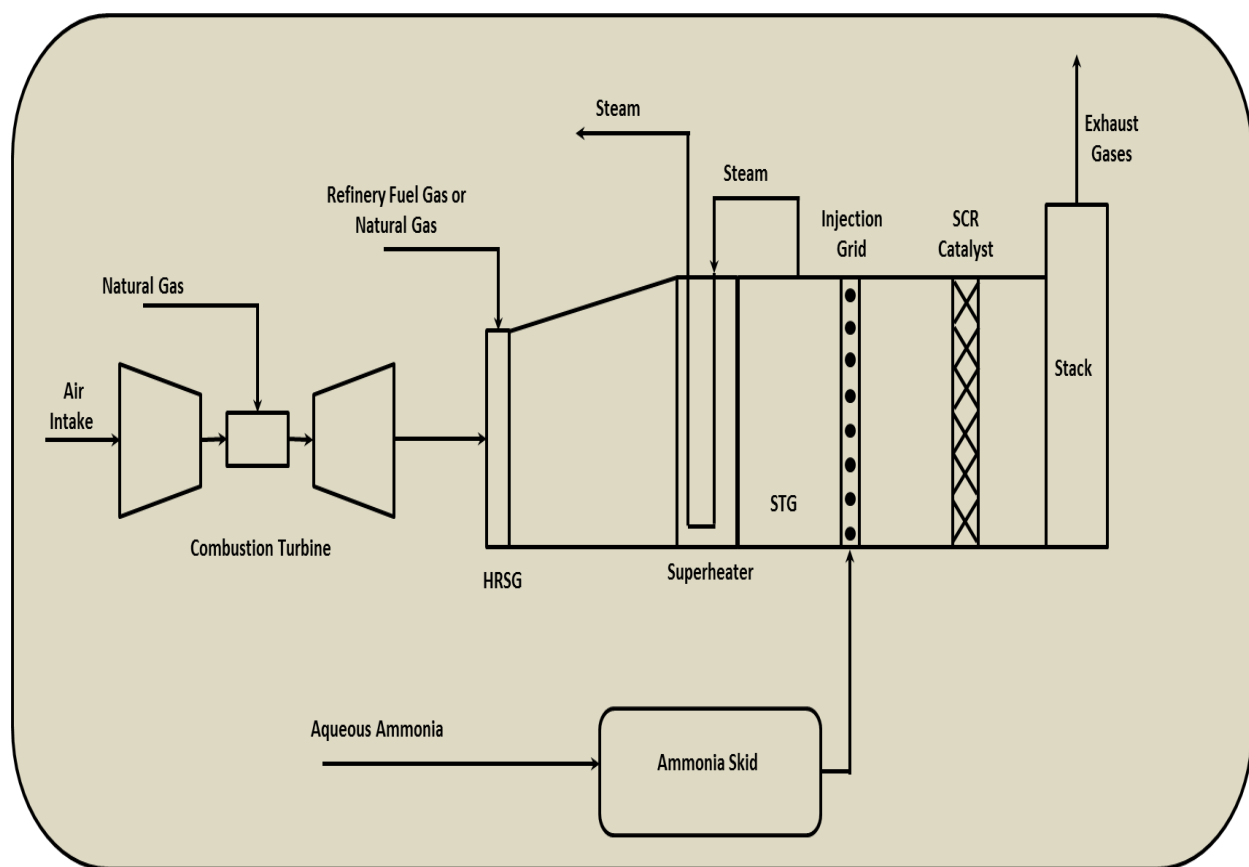
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A schematic depiction of the CCU with SCR is shown below.



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**Applicable Requirements – CCUs:****Table 1: Applicable Requirements**

<b>Source</b>	<b>Regulatory Citation</b>	<b>Description</b>	<b>Comments</b>
CCUs	Regulation No. 1102	Permits	This regulation is applicable to this project. This permit application is intended to meet DCRC's obligations under Regulation No. 1102.
	Regulation No. 1103	Ambient Air Quality Standards	This regulation applies to the Delaware City Refinery as a whole, not to any specific process or emissions unit.
	Regulation No. 1104	Particulate Emissions from Fuel Burning Equipment	This regulation applies to the CCUs. The PM emissions from the CCUs will continue to be limited to an emission rate less than 0.3 lb/MMBtu.
	Regulation No. 1106	Particulate Emissions from Construction and Materials Handling	Sections 2 and 3 of this regulation are potentially applicable to the CCU SCR Project during the construction phase of the project.
	Regulation No. 1108	Sulfur Dioxide Emissions from Fuel Burning Equipment	This regulation applies. However, this project will not impact DCRC's compliance with this regulation.
	Regulation no. 1110	Emissions of Sulfur Compounds from Industrial Operations	This regulation is applicable. DCRC's compliance with this regulation is based on compliance with the requirements of Regulation 1108

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Source	Regulatory Citation	Description	Comments
	Regulation No. 1112	Control of Nitrogen Oxide Emissions	This regulation applies. However, this project will not impact DCRC's compliance with this regulation.
CCUs	Regulation No. 1114	Visible Emissions	This regulation applies. However, this project will not impact DCRC's compliance with this regulation.
	Regulation No. 1117	Source Monitoring, Recordkeeping and Reporting	This regulation applies. However, this project will not impact DCRC's compliance with this regulation.
	Regulation No. 1119	Control of Odorous Air Contaminants	This regulation applies. However, this project will not impact DCRC's compliance with this regulation.
	Regulation No. 1120	New Source Performance Standards	See discussion of 40 CFR 60 Subpart Ja below.
	Regulation No. 1124	Control of Volatile Organic Compound Emissions	This regulation applies to the CCUs. However, this project will not impact DCRC's compliance with this regulation.
	Regulation No. 1125	Requirements for Preconstruction Review	The applicability of this regulation is discussed in greater detail below.
	Regulation No. 1130	Title V State Operating Permit Program	DCRC will have to submit an application to amend the Title V permit to incorporate the operating conditions that will be permitted pursuant to this application.

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Source	Regulatory Citation	Description	Comments
	Regulation No. 1147	CO <sub>2</sub> Budget Trading Program	This project will not affect the applicability of, or DCRC's compliance with the requirements of Regulation 1147.
CCUs	40 CFR 60 Subpart A	General Provisions	The NSPS general provisions codified at 40 CFR 60, Subpart A are applicable to stationary sources with facilities subject to any standard promulgated under Part 60. This project will not affect the applicability of, or DCRC's compliance with the requirements of Subpart A.
	40 CFR 60 Subpart Ja	Standards of Performance for Petroleum Refineries	This project will not allow an increase in the maximum hourly emission rate from the CCUs. Therefore, it is not a modification under NSPS and these units are not subject to Subpart Ja. Further, the scope of this project is not sufficient to trigger the 50% threshold associated with the definition of reconstruction.
	40 CFR 63 Subpart A	General Provisions	The NESHAP general provisions codified at 40 CFR 63, Subpart A are applicable to stationary sources with facilities subject to any standard promulgated under Part 63. The proposed project will not be subject to any new applicable requirements of Subpart A.

**Discussion of Applicability of 7 DE Admin. Code 1125:**

7 DE Admin. Code 1125 sets forth the requirements for preconstruction review with specific provisions to determine major source NSR and LAER applicability contained in Section 2 of this Regulation. According to 7 DE Admin. Code 1125, Section 2, provisions apply to any proposed new major stationary source or any proposed major modification. Section 2.2.1 defines a major stationary source for the refinery as any stationary source with the potential to emit over 25 tons per year VOCs or NO<sub>x</sub> emissions. 7 DE Admin. Code 1125 defines "stationary source" as any "building, structure, facility, or installation" and that phrase is defined under Section 1.9 as all the pollutant emitting activities associated with the industrial category of that source. In addition, Section 2.2.4 further defines "installation" to mean any individual process or equipment. Based on these definitions, a project at this facility can trigger Section 2 requirements in one of three ways. First, since the refinery is already a major stationary source for VOCs and NO<sub>x</sub>, Section 2 could apply if the proposed modifications result in a significant net increase

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in emissions (more than 25 tpy of VOCs and NOx) on a plantwide basis. Second, the refinery can trigger LAER if any individual process, which by itself is major, is modified in a way that results in a significant net increase in emissions for that process. Lastly, LAER can be triggered if a major source is reconstructed or built new.

The CCU SCR project could potentially trigger applicability of section 2 requirements because each CCU on its own has a PTE greater than 25 TPY NOx. However, as part of the DCRC agreement, a facility-wide NOx cap was established for the entire refinery which restricts NOx emissions as follows:

- The initial NOx Cap for the Refinery shall be 2525 tons per year, evaluated over each twelve (12) consecutive month rolling period, commencing with the rolling twelve (12) consecutive month period comprised by calendar year (CY) 2011 and ending with the twelve (12) consecutive month rolling period that ends on December 31, 2013.
- The NOx Cap will be further reduced to 2225 tons per year, evaluated over each twelve (12) consecutive month rolling period comprising calendar year 2014.
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The CCU SCR Project did not trigger 7 **DE Admin. Code 1125** because

- DCRC is not seeking a change in the above caps
- NOx emissions reductions attributable to the CCU SCR Project will result in CCU stack concentrations below 3 ppmvd @ 15 % O2 in the CCUs and 3.6 ppmvd @ 15 % O2 when the duct burners are also fired. The potential reductions in annual mass emissions that correspond to these post SCR concentrations are 267 TPY NOx/CCU.
- There will be a potential increase of 4.45 TPY H2SO4 from both CCUs, but this amount is lower than the 7 TPY significance threshold.
- The CCU SCR Project will result in up to (PTE) 34.3 TPY new NH3 emissions per CCU due to NH3 slip at 5 ppmvd @ 15 % O2.

Therefore, this CCU modification application has not been reviewed under NSR provisions for LAER technology determination.

### **Project Related Emissions:**

#### Emissions Calculations:

Max. CT firing rate: 780 mmBtu/hour

Duct burner firing rate: 191.8 mmBtu/hour

NG HHV: 1,020 Btu/dscf

RFG HHV: 1,069 Btu/dscf

CT operating time: 8760 hours/year

DB operating time: 8760 hours/year

Uncontrolled CCU NOx concentration 15 ppmvd @ 15 % O2 without duct firing

Uncontrolled CCU NOx concentration 18 ppmvd @ 15 % O2 with duct firing

Baseline H2SO4 emissions (Oct 2011 through Sept. 2013) = 3.8 TPY

SCR control efficiency: 80 %

NH3 usage rate: 25.4 GPH

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Aq. NH<sub>3</sub> strength: 19 % (wt)

Flue gas flow: 420,000 scfm

Stack O<sub>2</sub>: 12.6 %SCR NO<sub>x</sub> inlet concentration: 15 ppmvd @ 15 % O<sub>2</sub> without the duct burners and 18 ppmvd @ 15 % O<sub>2</sub> with the duct burnersSCR NO<sub>x</sub> outlet concentration: 3 ppmvd @ 15 % O<sub>2</sub> without the duct burners and 3.6 ppmvd @ 15 % O<sub>2</sub> with the duct burnersS in fuel conversion to SO<sub>2</sub> and H<sub>2</sub>SO<sub>4</sub>: 90 % and 10 % respectivelySCR NO<sub>x</sub> inlet loading to each CCU:

$$[18 \text{ scf NO}_x/10^6 \text{ scf flue}] \times [46 \text{ lb NO}_x/\text{lb mole NO}_x] \times [1 \text{ lb mole NO}_x/385.3 \text{ scf NO}_x] \times [420,000 \text{ scf flue/min}] \times [60 \text{ min/hr}] \times [(20.9 - 12.6)/(20.9 - 15)] \times [8760 \text{ hr/year}] \times [1 \text{ ton}/2000 \text{ lb}]$$
$$= 333.6 \text{ TPY NO}_x$$

SCR NO<sub>x</sub> outlet from each CCU:

$$[3.6 \text{ scf NO}_x/10^6 \text{ scf flue}] \times [46 \text{ lb NO}_x/\text{lb mole NO}_x] \times [1 \text{ lb mole NO}_x/385.3 \text{ scf NO}_x] \times [420,000 \text{ scf flue/min}] \times [60 \text{ min/hr}] \times [(20.9 - 12.6)/(20.9 - 15)] \times [8760 \text{ hr/year}] \times [1 \text{ ton}/2000 \text{ lb}]$$

$$= 66.7 \text{ TPY NO}_x$$

CCU H<sub>2</sub>SO<sub>4</sub> emissions = Sum of H<sub>2</sub>SO<sub>4</sub> formed from NG combustion in gas turbines + RFG combustion in duct burners

$$\text{H}_2\text{SO}_4 \text{ emissions from NG combustion: } [2 \text{ scf H}_2\text{S}/10^6 \text{ scf NG}] \times [1 \text{ scf NG}/1,020 \text{ Btu NG}] \times [10^6 \text{ Btu/mmbtu}] \times [1 \text{ lb mole H}_2\text{S}/385.3 \text{ scf H}_2\text{S}] \times [0.1 \text{ mole H}_2\text{SO}_4/\text{mole H}_2\text{S}] \times [98.07 \text{ lb H}_2\text{SO}_4/\text{mole H}_2\text{SO}_4]$$
$$= 4.99\text{E} -05 \text{ lb H}_2\text{SO}_4/\text{mmBtu}$$

$$\text{H}_2\text{SO}_4 \text{ emissions from RFG DB combustion in DBs: } [196.7 \text{ scf S}/10^6 \text{ scf RFG}] \times [1 \text{ scf RFG}/1,069 \text{ Btu RFG}] \times [10^6 \text{ Btu/mmbtu}] \times [1 \text{ lb mole H}_2\text{S}/385.3 \text{ scf H}_2\text{S}] \times [0.1 \text{ mole H}_2\text{SO}_4/\text{mole H}_2\text{S}] \times [98.07 \text{ lb H}_2\text{SO}_4/\text{mole H}_2\text{SO}_4]$$
$$= 4.79 \text{ E} -03 \text{ lb H}_2\text{SO}_4/\text{mmBtu}$$

$$\text{Total H}_2\text{SO}_4 \text{ emissions} = [4.99 \text{ E} -05 \text{ lb H}_2\text{SO}_4/\text{mmBtu}] \times [780 \text{ mmBtu/hour}] + [4.7 \text{ E} -03 \text{ lb H}_2\text{SO}_4/\text{mmBtu}] \times [192 \text{ mmbtu/hour}] \times [8760 \text{ hours/year}] \times [1 \text{ ton}/2000 \text{ lb}]$$
$$= 4.1 \text{ TPY per CCU}$$

NH<sub>3</sub> emissions:

$$[5 \text{ scf NH}_3/10^6 \text{ scf flue}] \times [17 \text{ lb NH}_3/\text{lb mole NH}_3] \times [1 \text{ lb mole NH}_3/385.3 \text{ scf NH}_3] \times [420,000 \text{ scf flue/min}] \times [60 \text{ min/hr}] \times [(20.9 - 12.6)/(20.9 - 15)] \times [8760 \text{ hr/year}] \times [1 \text{ ton}/2000 \text{ lb}]$$

$$= 34.3 \text{ TPY NH}_3$$

These individual PTEs inclusive of the NO<sub>x</sub> concentration based limits when the SCRs are operating have been incorporated in the CCU permit. The monitoring, recordkeeping and reporting requirements remain



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unchanged. Because the existing DCPD permits have combined annual mass emission limits for the boilers and the CCUs those limits will continue to apply. The annual combined NOx mass emission limit has been subsumed in the facility-wide NOx cap.

**Recommendation:**

The application was initially public noticed on November 17, 2013 and a draft permit incorporating the associated emissions limits discussed above was developed and shared with the facility for its input. DCRC disagreed that the permit should include conditions specifying SCR outlet NOx concentration limits and with the requirement to operate the control devices when the CCUs are operating. DAQ and DCRC made attempts at resolving these two outstanding issues on the CCU SCR Project draft permit over the last 2 months. But, despite these efforts, DCRC concluded that we have arrived at an impasse in these negotiations. Consequently, to move the process forward DAQ is opening an official docket to allow DCRC an opportunity to comment on the record as well as soliciting comments from EPA and the public on the application and draft permit. At the conclusion of this process or any public hearing that may ensue, DAQ will be able to issue a federally enforceable construction permit. The associated legal notices are expected to run on Wednesday 05.14.2014 and Sunday 05.18.2014. Consequently, at this time, it is recommended that the permit application and draft permit be made available for public review for 30 days.

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